

What is claimed is:

1. A method of sputter depositing deposition material onto a substrate supported by a pedestal in a chamber, comprising:

rotating a magnetron about the back of a target in the chamber, said magnetron having an area of no more than about 1/4 of the area of the target and including an inner magnetic pole of one magnetic polarity surrounded by an outer magnetic pole of an opposite magnetic polarity, a magnetic flux of said outer pole being at least 50% larger than the magnetic flux of said inner pole;

applying power to said target to thereby sputter material from said target onto said substrate at a first rate;

applying RF power to said pedestal to provide a plasma to resputter deposition material on said substrate; and

confining said plasma using a magnetic field generated by electromagnetic coils disposed around the periphery of the pedestal.

2. The method of claim 1 wherein said target is spaced from said pedestal by a throw distance that is greater than 50% of a diameter of the substrate.

3. The method of claim 1 further comprising inhibiting sputtering said target while resputtering target material on said substrate.

4. The method of claim 3 wherein said inhibiting includes reducing the power applied to said target.

5. The method of claim 4 wherein the power applied to said target is reduced to less than 1 kW.

6. The method of claim 5 wherein the power applied to said target is reduced to 100-200 watts.

7. The method of claim 3 wherein said inhibiting includes reducing the voltage applied to said target.

8. The method of claim 7 wherein the voltage applied to said target is reduced to zero volts.

9. The method of claim 1 further comprising inhibiting sputtering said target while resputtering target material on said substrate wherein said inhibiting includes reducing the power applied to said target to 100-200 watts and wherein said confining includes applying 5 A of current to a first electromagnetic coil.

10. The method of claim 1 wherein said confining includes applying 5 A of current to a first electromagnetic coil.

11. The method of claim 1 wherein said confining includes applying 10 A of current to a first electromagnetic coil.

12. The method of claim 11 wherein said confining includes applying -5 A of current to a second electromagnetic coil.

13. The method of claim 1 further comprising raising the pressure of said chamber while resputtering said substrate.

14. The method of claim 1 wherein RF power is applied in a range of 150-300 watts while sputtering material from said target.

15. The method of claim 1 wherein said chamber has an internal pressure of 1-10 mTorr during said resputtering.

16. The method of claim 15 wherein said chamber has an internal pressure of 1-5 mTorr during said resputtering.

17. The method of claim 16 wherein said chamber has an internal pressure of 2 mTorr during said resputtering.

18. The method of claim 15, wherein said target is spaced from said pedestal by a throw distance that is greater than 50% of a diameter of the substrate and wherein said pressure is less than 5 milliTorr.

19. The method of claim 18, wherein said throw distance is greater than 80% of said diameter of the substrate.

20. The method of claim 19, wherein said throw distance is greater than 140% of said diameter of the substrate.

21. The method of claim 1 wherein said deposition material is tantalum nitride.

22. The method of claim 1 wherein said deposition material is tantalum.

23. The method of claim 1, wherein said material is one of tantalum and tantalum nitride which is deposited into a hole formed in a dielectric layer of said substrate and having an aspect ratio of at least 4:1.

24. A method of sputter depositing a layer of metal material into a plurality of holes on a substrate, comprising:

providing a chamber having a target spaced from a pedestal for holding a substrate to be sputter coated by a throw distance that is greater than 50% of a diameter of the substrate;

rotating a magnetron about the back of the target, said magnetron having an area of no more than about 1/4 of the area of the target and including an inner magnetic pole of one magnetic polarity surrounded by an outer magnetic pole of an opposite magnetic polarity, the magnetic flux of said outer pole being at least 50% larger than the magnetic flux of said inner pole;

applying at least 10 kW of DC power to said target while said chamber is pumped to a vacuum pressure, to thereby sputter material from said target onto said substrate and to maintain a self ionizing plasma to ionize at least a portion of said material sputtered from said target;

biasing said substrate to attract sputtered material ions;

reducing said DC power applied to said target after depositing a layer of target material into holes on said substrate;
supplying a precursor gas into said chamber;
applying RF power to said pedestal to capacitively couple RF energy into a plasma to ionize said precursor gas and to bias said substrate to attract ionized gas to resputter target material from the bottom of the holes of said substrate; and
generating a magnetic field to surround said pedestal and confine said plasma to increase the density of said plasma.

25. A plasma sputter reactor system for sputter depositing a film on a substrate, comprising:

a vacuum chamber containing a pedestal aligned to a chamber axis and having a support surface for supporting a substrate to be sputter deposited;
a first power source coupled to said pedestal and adapted to provide RF power to said pedestal;
a target comprising a material to be sputter deposited on said substrate and electrically isolated from said vacuum chamber;
a second power source coupled to said target and adapted to provide power to said target to bias said target;
a magnetron disposed adjacent said target and having an area of no more than about 1/4 of the area of the target and including an inner magnetic pole of one magnetic polarity surrounded by an outer magnetic pole of an opposite magnetic polarity, the magnetic flux of said outer pole being at least 50% larger than the magnetic flux of said inner pole;
a first electrically conductive shield generally symmetric about said axis, supported on and electrically connected to said chamber, and extending away from said target along a wall of said chamber to an elevation behind said support surface;
an electromagnetic coil carried by said first shield and surrounding said shield;
a third power source coupled to said coil and adapted to energize said coil to generate a magnetic field surrounding said pedestal; and
a controller adapted to control said second power source to sputter said target in a first interval at a first power level and to reduce said power level to a second level in a second interval wherein target material is sputtered on said substrate primarily in said first interval, said controller being further adapted to control said first power source to provide

RF power to said pedestal to bias a substrate on said pedestal and to capacitively couple RF power to maintain a plasma in said chamber in said second interval wherein target material deposited on said substrate in said first interval is resputtered from said substrate in said second interval, and said controller being further adapted to control said third power source to provide a magnetic field to surround said pedestal and confine said plasma to increase the density of said plasma in said second interval.

26. The reactor system of claim 25 wherein said controller is adapted to control the pressure in said chamber to a pressure of no more than 5 milliTorr during at least a portion of said sputtering during said first interval.

27. The reactor system of claim 25 wherein said controller is adapted to control the pressure in said chamber to a pressure of no more than 5 milliTorr during at least a portion of said resputtering during said second interval.

28. The reactor system of claim 26 wherein said chamber has an internal pressure of 2 mTorr while resputtering said substrate.

29. The reactor system of claim 26 wherein said controller is adapted to raise the pressure of said chamber while resputtering said substrate.

30. The reactor system of claim 25 wherein said target is spaced from said pedestal by a throw distance that is greater than 50% of a diameter of the substrate.

31. The reactor system of claim 30, wherein said throw distance is greater than 80% of said diameter of the substrate.

32. The reactor system of claim 31, wherein said throw distance is greater than 140% of said diameter of the substrate.

33. The reactor system of claim 25 wherein during said second interval, said target power is less than 1 kW.

34. The reactor system of claim 33 wherein during said second interval, said target power is 100-200 Watts.

35. The reactor system of claim 25 wherein during said first interval, said target power is at least 10 kW DC.

36. The reactor system of claim 35 wherein during said first interval, said target power is at least 20 kW DC.

37. The reactor system of claim 25 wherein said controller is adapted to control said third source to provide no power to said coil during said sputter deposition of said first interval.

38. The reactor system of claim 25 wherein said controller is adapted to control said second power source to reduce the voltage applied to said target during said second interval.

39. The reactor system of claim 38 wherein said controller is adapted to control said second power source to reduce the voltage applied to said target to zero volts.

40. The reactor system of claim 25 wherein during said second interval, said target power is 100-200 Watts and wherein during said first interval, said target power is at least 20 kW DC.

41. The reactor system of claim 25 wherein said controller is adapted to control said third power source to energize said electromagnetic coil with 5 A of current during said second interval.

42. The reactor system of claim 25 wherein said controller is adapted to control said third power source to energize said electromagnetic coil with 10 A of current during said second interval.

43. The reactor system of claim 42 further comprising a second electromagnetic coil carried by said first shield and surrounding said shield, and a fourth power source

coupled to said coil and adapted to energize said second coil to generate a magnetic field surrounding said pedestal, and wherein said controller is adapted to control said fourth power source to energize said second electromagnetic coil with -5 A of current.

44. The reactor system of claim 25 wherein said target material is tantalum.

45. The reactor system of claim 44 further comprising an inlet adapted to provide nitrogen wherein said controller is adapted to control said inlet to provide nitrogen in said chamber while said target is sputtered wherein tantalum nitride is deposited onto said substrate.

46. A reactor system for depositing conductive material onto a substrate, comprising:

target means for sputter depositing a layer of conductive material onto said substrate, and for generating a self ionized plasma to ionize a portion of said conductive material sputtered from said target means prior to being deposited onto said substrate;

capacitively coupled plasma means including a pedestal electrode, for generating a capacitively coupled plasma, and for biasing a substrate to attract plasma ions to resputter a portion of said conductive material from said substrate; and

electromagnetic coil means for generating a magnetic field to surround said pedestal and confine said plasma to increase the density of said plasma adjacent said pedestal electrode.

47. The reactor system of claim 46 wherein said target means includes a target comprising a conductive material to be sputter deposited on said substrate and a magnetron disposed adjacent said target and having an area of no more than about $1/4$ of the area of the target and including an inner magnetic pole of one magnetic polarity surrounded by an outer magnetic pole of an opposite magnetic polarity, the magnetic flux of said outer pole being at least 50% larger than the magnetic flux of said inner pole.

48. The reactor system of claim 46 wherein said pedestal electrode is positioned to support said substrate in said reactor system, and wherein said capacitively coupled plasma means further includes RF generator means for applying RF energy to said RF pedestal electrode.

49. The reactor system of claim 46 wherein said target means includes a target sputtering surface and said pedestal electrode is adapted to support a substrate and wherein said target is spaced from said pedestal electrode by a throw distance that is greater than 50% of a diameter of the substrate.

50. The reactor system of claim 46 further comprising controller means for inhibiting sputtering by said target means while target material is resputtered from said substrate by said capacitively coupled plasma means.